



Introduction



IGS RT Infrastructure

- Participation from 34 organisations
 - 10 participating Analysis Centres
 - ESOC is the AC Coordinator, responsible for the combination
- Data and Product Dissemination Infrastructure
 - Station operators > 100 RT observation streams
 - NTRIP infrastructure from BKG
 - RTIGS infrastructure from NRCan now moving to NTRIP/RTCM









Introduction



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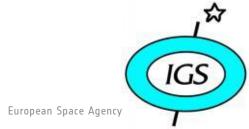
- >RTPP Objectives and Achievements
- >Transition to IGS Operational Service
- Operational Service Redundancy Concepts











Historical Background



- IGS RTWG Charter 2001
 - Design and implement real-time infrastructure and processes → network → data → products (iono, clock and orbits) → users
- ❖ IGS RTPP 2007 2010
 - > 2009 extended until end of 2011
- 2010 RTWG and RTPP charter combined
 - ➤ 2011-2012 plan → projects IGS rt-services starting
- RT-Services are a part of the IGS strategic plan
 - ➤ IGS → IAG Service → GGOS Natural Hazards theme











RTPP Key Objectives



- Investigate standards and formats for real-time data collection and data and product dissemination
- Manage and maintain a global GNSS real-time tracking network
- Generate real-time products
 - Clock accuracies of 0.3 ns (originally 0.5 ns)
 - Orbit accuracies of 5-6 cm
 - Latency of better than 10 sec
- Monitor the integrity of IGU predicted orbits and GNSS status









RTPP Achievements

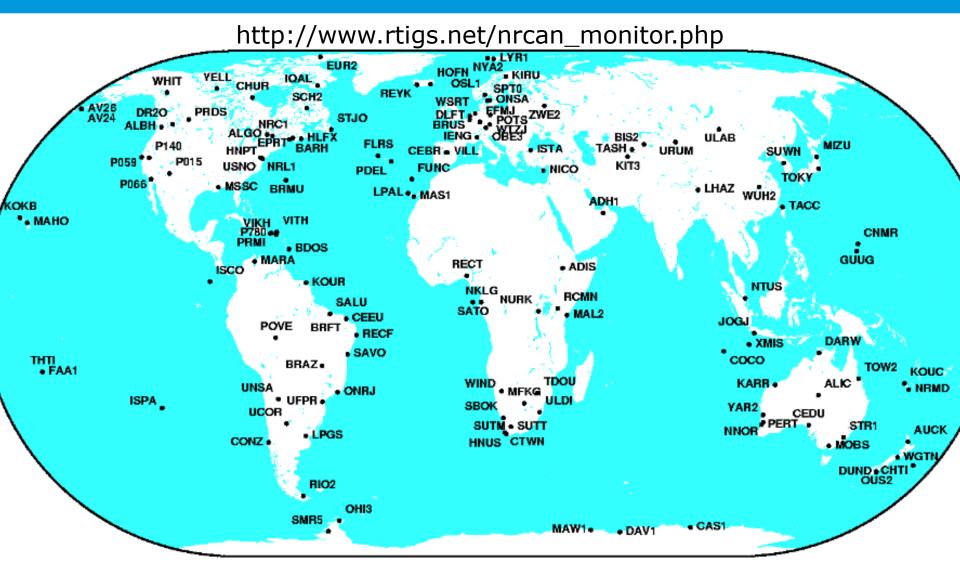


Development of standards and formats for RT

- ➤ IGS has joined the Radio Technical Commission for Maritime Services (RTCM) - Mainly represented by NRCan, ESOC, BKG and IGSCB
 - MSM HP formats to satisfy RINEX 3 and multiconstellation requirements
 - Product dissemination via new SSR formats (GPS and GLONASS formats in place)
 - Latest development: Joint IGS-RTCM Working Group on RINEX evolution, chaired by K. MacLeod
 - RINEX 3.02 draft released among WG members
- BKG, NRCan and others developing software to support these standards

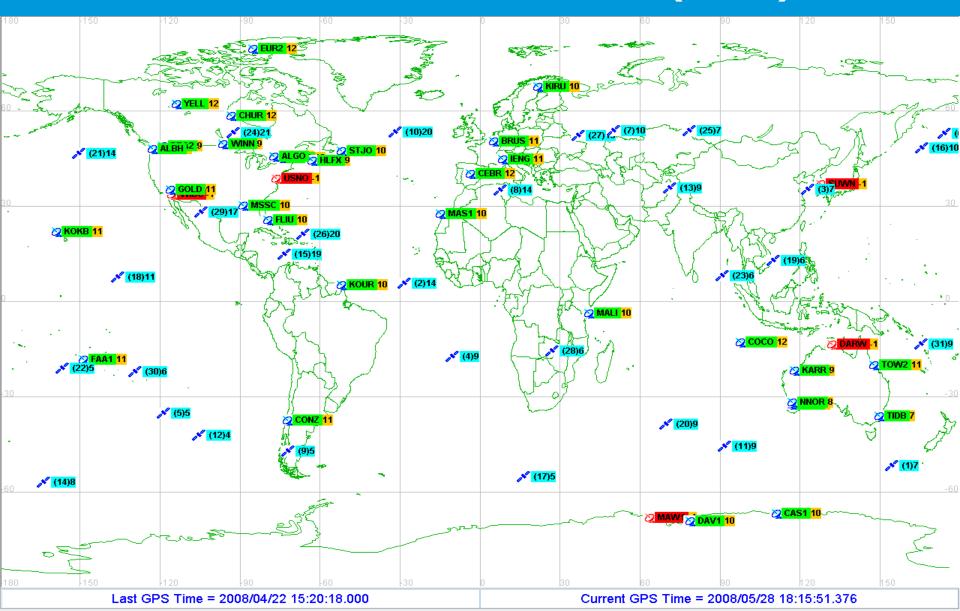
GNSS Tracking Network Current RT Tracking Network





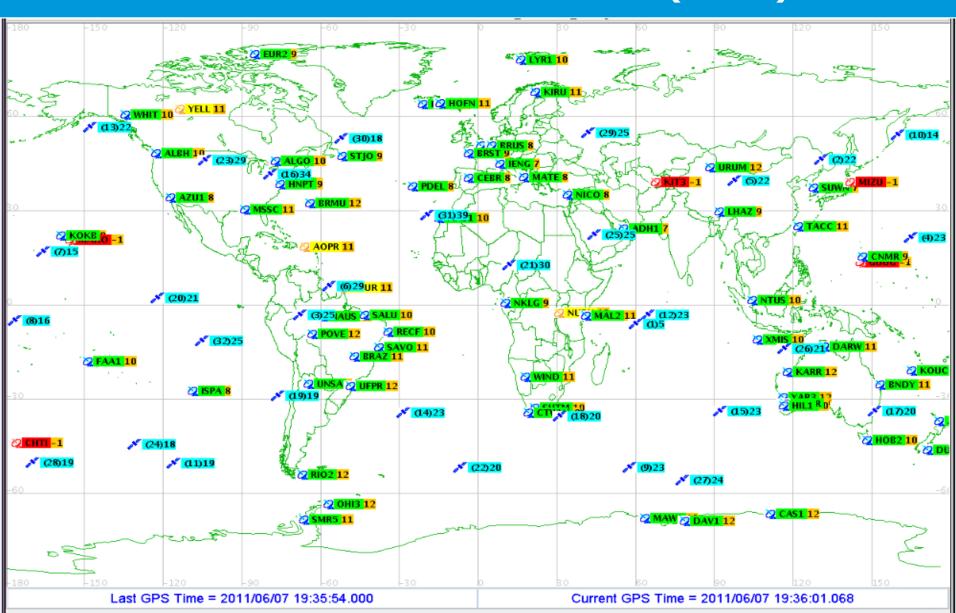
GNSS Tracking Network Stations in ESOC RT Solution (2008)





GNSS Tracking Network Stations in ESOC RT Solution (2011)





RTPP Achievements



Generation of Real-Time Products

- > 10 ACs provide a multitude of product streams
 - GPS-only solutions from each AC, with 3 (soon to be 4)
 GPS+GLONASS
- ESOC provides the RT combination product (GPS-only)
 - Each epoch independently combined (no convergence needed)
 - Outlier detection for clocks and orbits
 - Will transition to the IGS operational product
- BKG generates clock combination products based on Kalman filter combination
- Ambiguity-fixing WG studying techniques and formats for PPP ambiguity fixing
- UPC and DLR are generating RT ionospheric products









Real-Time Products



RTCMSSR

CLK22

CLK80/81

CLK15/16

	CSa	
Centre	Description	NTRIP Mountpoint
	GPS and GPS + GLONASS RT orbits and clocks using IGU orbits (CoM/APC)	CLK00/10 CLK01/11
CNES	GPS RT orbits and clocks based on IGU orbits (CoM/APC) GPS+GLONASS orbits and clocks (CoM/APC)	CLK92/93 CLK90/91
DLR	GPS RT orbits and clocks based on IGU orbits GPS+GLONASS orbits and clocks (DLR caster)	CLKC1/A1 CLK21
ESOC	RT orbits and clocks using NRT batch orbits every 2 hours (ESOC) and using IGU (ESOC2) (CoM /APC)	CLK50/51 CLK52/53
		aa

TU Prague	orbits (CoM/APC)
	GPS RT orbits and clocks based on IGU orbits (CoGPS+GLONASS orbits and clocks (CoM/APC)
	GPS RT orbits and clocks based on IGU orbits GPS+GLONASS orbits and clocks (DLR caster)
	RT orbits and clocks using NRT batch orbits every (ESOC) and using IGU (ESOC2) (CoM /APC)

NRCan

TUW

WUHAN

(APC)

CLK70/71 1/APC) CLK81/80

CNES	GPS RT orbits and clocks based on IGU orbits (CoM/APC) GPS+GLONASS orbits and clocks (CoM/APC)
DLR	GPS RT orbits and clocks based on IGU orbits GPS+GLONASS orbits and clocks (DLR caster)
	RT orbits and clocks using NRT batch orbits every 2 hours (ESOC) and using IGU (ESOC2) (CoM /APC)
GFZ	RT orbits and clocks and IGU orbits (CoM/APC)

RT orbits and clocks using NRT batch orbits every hour

RT clocks based on IGU orbits (CoM/APC) (out of service)

ESOC	RT orbits and clocks using NRT batch orbits every 2 ho (ESOC) and using IGU (ESOC2) (CoM /APC)
GFZ	RT orbits and clocks and IGU orbits (CoM/APC)
GMV	RT orbits and clocks based on NRT orbit solution (CoM
Geo++	RT orbits and clocks (APC) (Geo++ caster)

RT clocks based on IGU orbits (CoM/APC)

Real-Time Products RT Combination Streams



Centre	Description	NTRIP Mountpoint
ESOC	RT GPS-only combination from BKG, CNES, DLR, ESOC, GMV and GFZ streams (CoM /APC)	IGS01/ IGC01
	RT GPS-only Kalman-generated combination from BKG, CNES, DLR, ESOC, GMV and GFZ streams (CoM /APC) RT GPS+GLONASS Kalman-generated combination from	IGS02/ CLK32
	BKG, CNES, DLR, ESOC, GMV and GFZ streams (APC)	IGS03











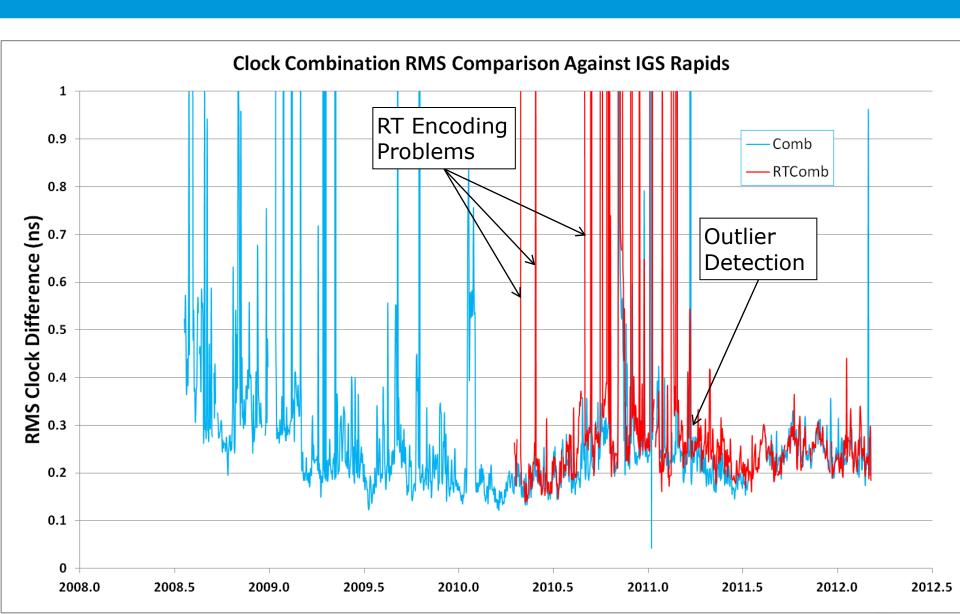
AC Performance



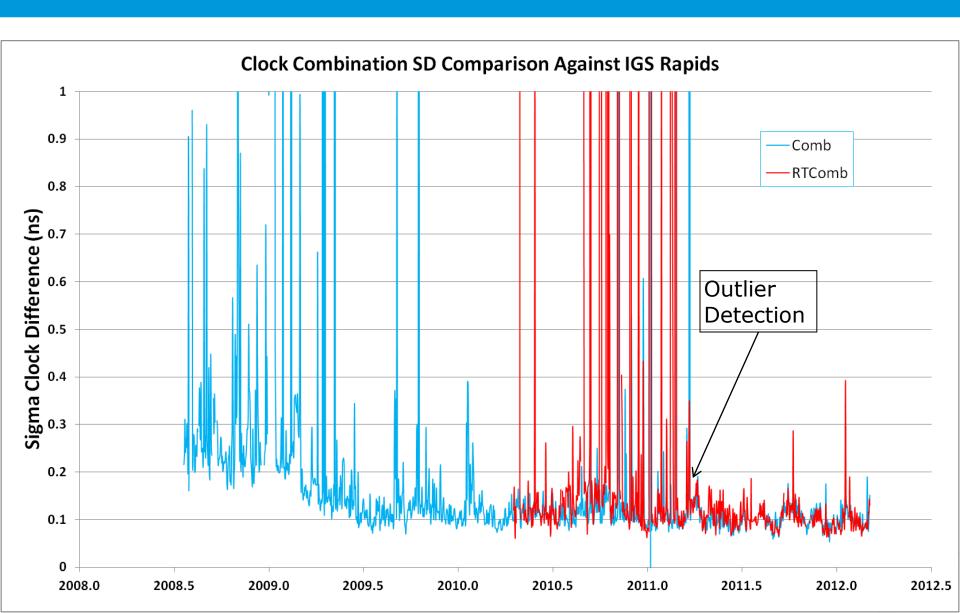
Snapshots of AC Satellite Clock Results

						
	Feb 6 2009		June 8 2010		June 15 2011	
AC	Clock RMS (ns)	Clock Sigma (ns)	Clock RMS (ns)	Clock Sigma (ns)	Clock RMS (ns)	Clock Sigma (ns)
Comb	0.29	0.22	0.16	0.10	0.14	0.07
RTComb	-	-	0.15	0.11	0.18	0.08
BKG	6.72	2.97	0.20	0.12	0.30	0.07
CNES	-	-	-	_	0.30	0.03
DLR	0.38	0.10	0.20	0.12	0.25	0.12
ESOC	0.42	0.38	0.21	0.12	0.17	0.12
ESOC2	0.36	0.30	0.19	0.11	0.16	0.08
GFZ	-	-	-	-	0.33	0.06
NRC	0.67	0.62	0.24	0.10	0.23	0.07
GMV	1.67	1.66	0.28	0.14	0.34	0.10
TUW			0.70	0.53	0.73	0.53 13

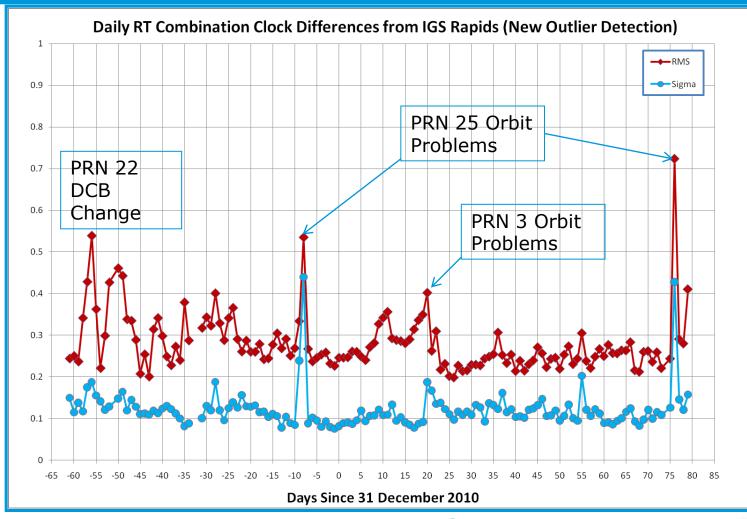












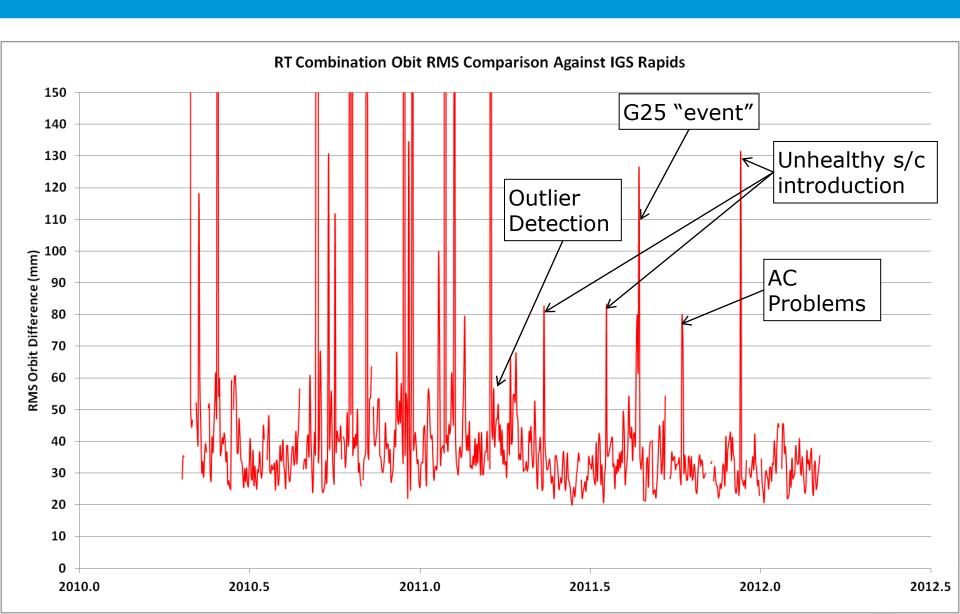






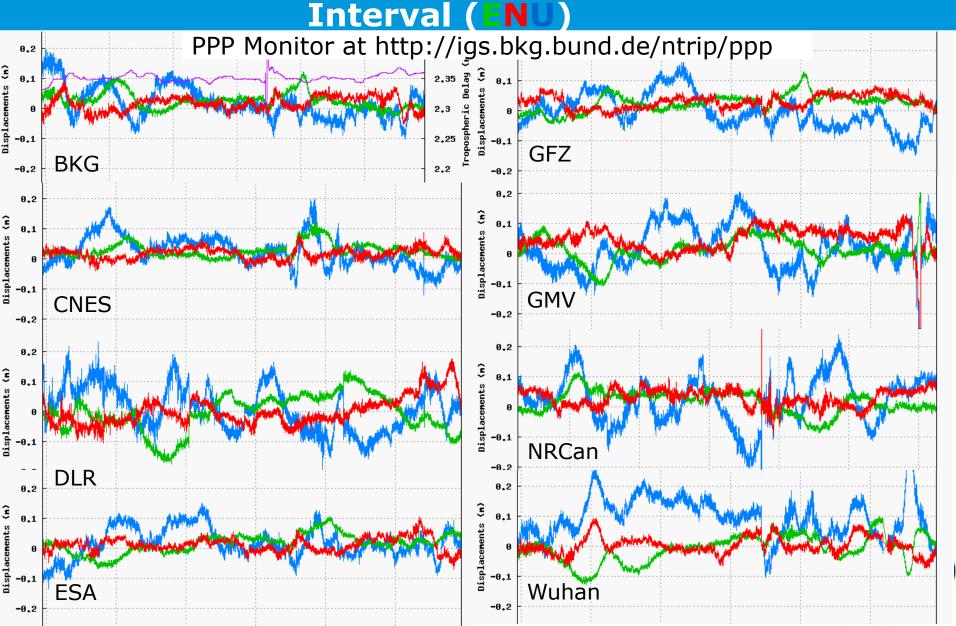






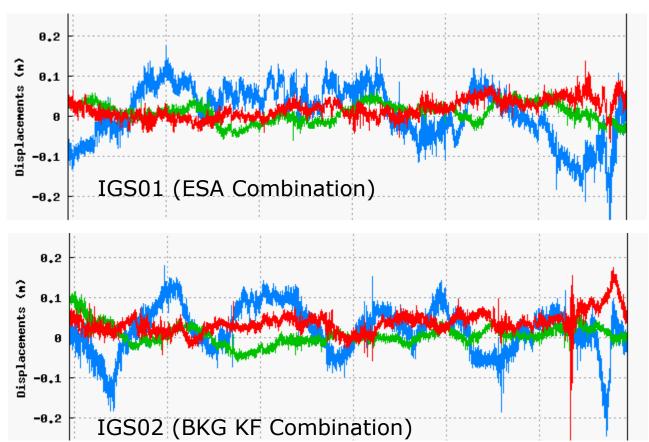
PPP Performance Kinematic PPP Displacements in 24 h





PPP Performance Kinematic PPP Displacements in 24 h Interval (ENU)





PPP Monitor at http://igs.bkg.bund.de/ntrip/ppp











Product Performance Summary



- Accuracy (compared to IGS Rapids)
 - Orbit: 2-5 cm 1-D RMS
 - Clock RMS: 0.2-0.3 ns
 - Clock Sigma: 0.1 ns
- Latency
 - ➤ Latency of Individual Solutions: 5-15 sec
 - ▶ Latency of Combination: 20 25 sec
- PPP Performance
 - > 2-D RMS of 4-5 cm after convergence











Ambiguity Fixing WG



- WG established at 2010 IGS Workshop in Newcastle
- CNES and GFZ now compute products for PPP ambiguity fixing
- RTCM UPD format has been proposed by CNES and GFZ/Alberding and discussed with Geo++
- GFZ RT PPP results for about 80 stations are published on kg6-dmz.gfz-potsdam.de/rtgnss and CNES results are on www.ppp-wizard.net





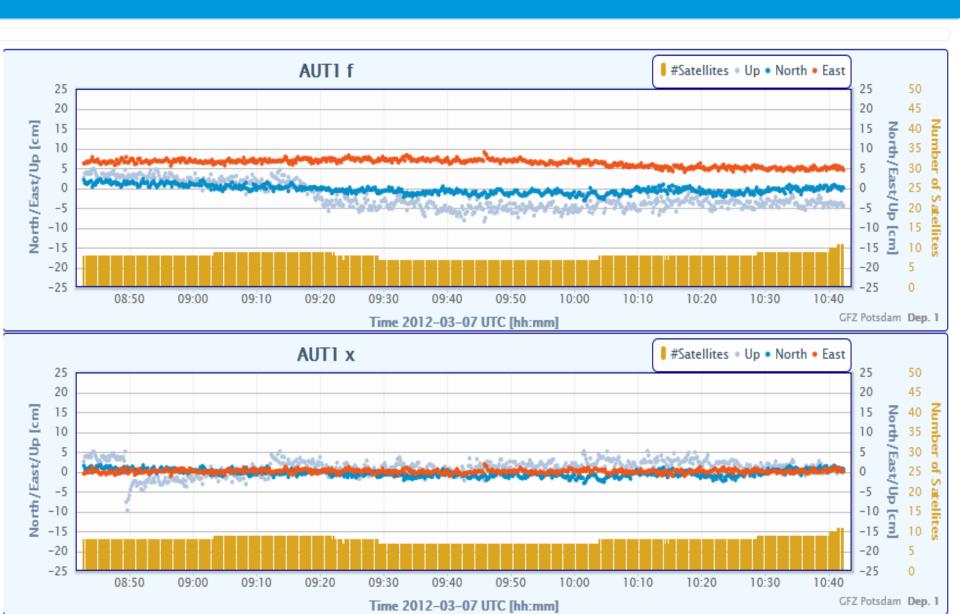






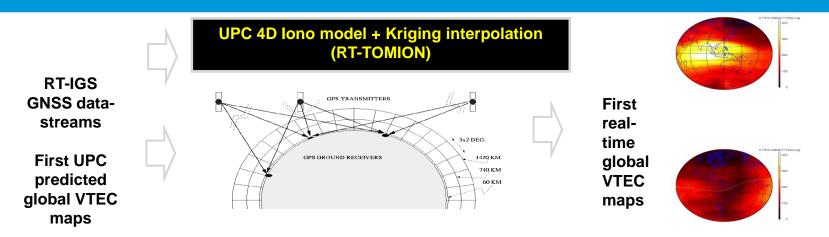
Ambiguity Fixing Results esa





RT-IGS global VTEC: First results





- Participation from DLR and UPC
- RT-VTEC map (2D) in IONEX format, 15 minutes rate and latency (in future it could be provided as 3D grid and data stream)
- Main problem found so far: lack of globally-distributed receivers
- Comparisons suggest that both UPC and DLR results, using a sufficient number of available receivers, could be compatible for a combination solution with hopefully better performance than any one of the individual real-time maps
- New assessments of DLR and UPC RT-VTEC maps against JASON data are being conducted with the objective of generating combined RT-IGS VTEC products











Transition to Operational Service



- RTPP participants are being asked to confirm their commitment to an operational service
- Initial Service in Q3 2012
 - GPS-only combination
 - Stage 1 Redundancy Concept to be implemented
 - Stage 2 Redundancy Concept to be phased in gradually
- Other products to be added later:
 - KF combination
 - Multi-GNSS products





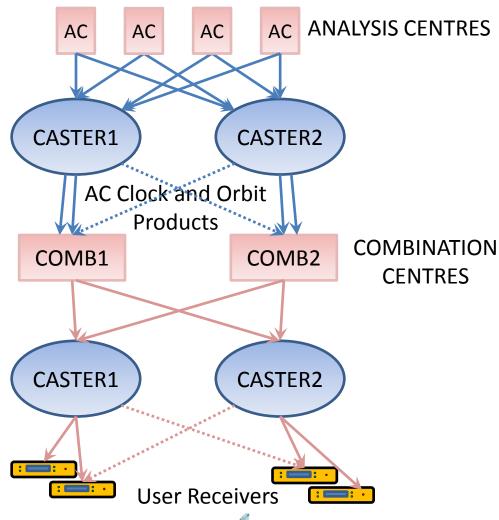






Redundancy Concept Stage 1







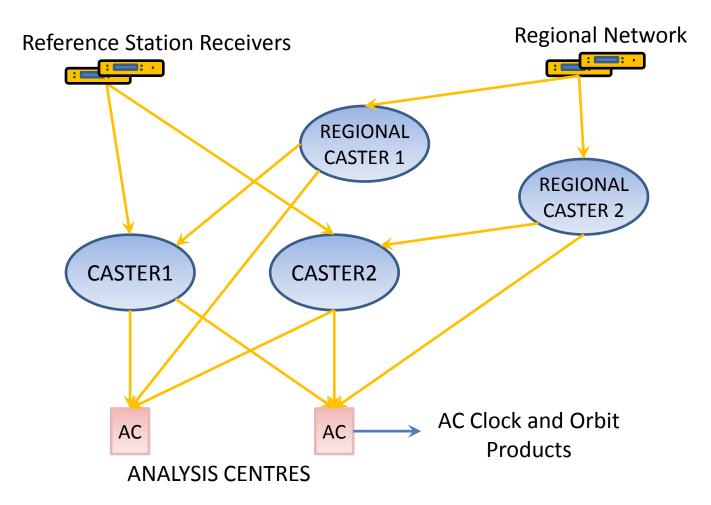






Redundancy Concept Stage 2













Conclusions



- RTPP data and products have been available since 2008
- Formats and processes are now ready to allow an initial operational service in Q3 2012
- Interested users who may want to test the combination products earlier can contact the RTWG for access and complete an online registration form:
 - http://register.rtcm-ntrip.org
 - Mark Caissy caissy@nrcan.gc.ca
 - Georg Weber georg.weber@bkg.bund.de
 - Loukis Agrotis loukis.agrotis@esa.int











Acknowledgements



* BKG

Data and product dissemination, RTCM and NTRIP software, PPP client, NTRIP web site

NRCan

Data dissemination, udpRelay software, RTCM, RINEX Working Group, PP web site

ESOC

- Sponsoring of AC Coordination Activities, RTCM, RINEX Working Group
- ACs and station operators/data providers
- ❖ IGSCB (and GB)
 - > Support of RTPP, data and product dissemination









